

# CHILDREN'S SCHOOL BUS EXPOSURE STUDY

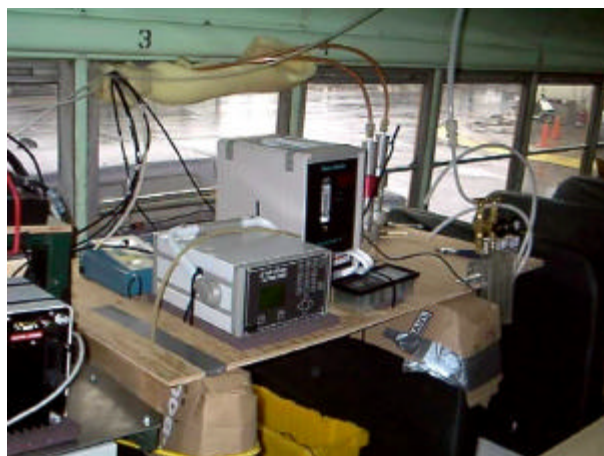
## Introduction

About 70% of California school buses are diesel-powered. Concerned that children's time spent near diesel school bus exhaust during school commutes may be a health concern, the Air Resources Board launched a detailed study of pollutant concentrations inside and near school buses, so that children's exposures during their bus commutes can be calculated. The study is being carried out in the Los Angeles Basin, headed by researchers at the University of California at Riverside and at Los Angeles. The pilot study was conducted in December, 2001, and the main field work was conducted in May and June, 2002.

## Methods

Buses of various ages and fuel types were driven over actual school bus routes, with stopping times and door action to simulate the pick-up and drop-off of children. During these runs, measurements were taken at different locations on the bus as well as just outside the bus. The bus interior was outfitted with an array of measurement equipment, mounted on platforms and/or attached to the seats as shown in the following photo.

Because traffic conditions change rapidly, the study used many special continuously-measuring instruments, along with other standard instruments, to allow measurement of short time concentration peaks and any rapid changes in concentrations. Continuous measurements included those for:



- particle mass (PM10 and PM2.5),
- particle number counts (ultrafine and fine),
- carbon monoxide,
- nitrogen dioxide,
- total volatile organic compounds (VOCs),
- formaldehyde,
- black carbon, and,
- particle-bound polycyclic aromatic hydrocarbons (PAHs).

Total PM mass (PM10 and PM2.5), particulate metals, and individual VOC and aldehyde species were also measured for each run.

Measurements were combined with video and observer records of traffic and driving conditions, and are being separated statistically to determine the conditions associated with high concentrations, and to determine the typical concentrations associated with the various portions of a child's bus commute. In addition, an inert tracer gas was added to each bus's exhaust to aid in distinguishing the bus's own emissions from those of surrounding vehicles.

Data are also being analyzed to investigate:

- 1) the effects of open versus closed windows,
- 2) differences in concentrations by front and back seat location,
- 3) differences in concentrations inside the bus versus just outside the bus,
- 4) concentration changes experienced during bus stops and loading, both on the bus and at bus stops, and,
- 5) the relative effect of a bus's own emissions on children's exposures relative to those from other vehicles.

Comparisons will include diesel fuels versus natural gas fuels and the effectiveness of diesel particulate traps.

### A SAMPLE OF STUDY MEASUREMENTS

Like previous studies of in-vehicle concentrations, pollutant concentrations inside the bus varied rapidly over time in the pilot study (see Figures 1 and 2, for carbon monoxide, for example.)

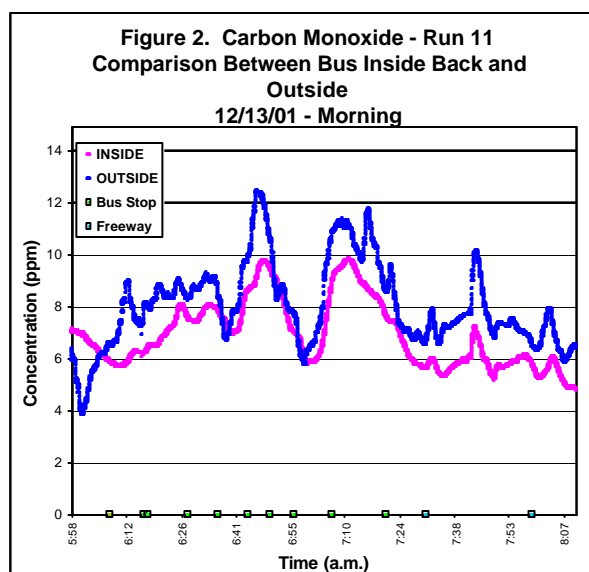
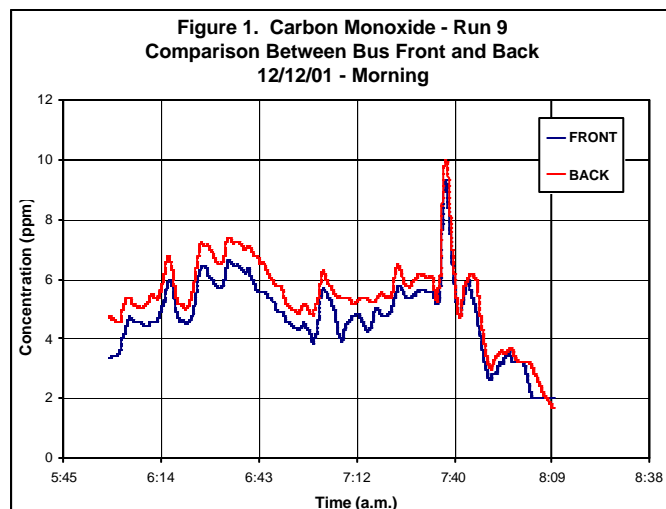


Figure 1 shows the close relationship between the front of the bus and the back, and Figure 2 shows the typical relationship between inside and outside the bus, where peak concentrations may vary significantly between inside and immediately outside the bus.

Due to the many things that affect the pollutant concentrations, such as bus speed and the number and types of surrounding vehicles, analysis of results such as these is complex. Because road-related pollutants can be contributed by many surrounding vehicles, some of which emit the same pollutants as a school bus, determining the bus's own contribution is challenging. It is important to keep in mind that pollutant concentrations inside any vehicle while driving in heavy traffic are significantly higher than other outdoor concentrations away from traffic.

### SIGNIFICANCE OF STUDY

It is anticipated that this study will be the most complete study of its type to date, with its large number of pollutants being measured, its large number of bus runs, and the use of a tracer gas in the bus exhaust. The results will be very useful in calculating children's exposures to pollutants during their school bus commute and in determining whether children's exposures to vehicle and bus pollutants during their school bus commutes are unduly high. Final results are expected to be available in Spring, 2003.